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SCIENCE AND EVERY-DAY PHILOSOPHY[1]

By President WILLIAM E. WICKENDEN

CASE SCHOOL OF APPLIED SCIENCE

WE are gathered in this distinguished seat of learning to acclaim these new companions in research, who by their zeal, their intellectual integrity and their devotion to the ideals of science have shown themselves worthy to share in the pursuit of truth. Meanwhile John Does by the thousand stroll along, roll along on the streets of your fair city, scarcely aware of your existence and less aware of being in your debt. To them you are just a bunch of highbrows—a queer lot who get some freakish sort of kick out of peering down microscopes, messing around with ill-smelling chemicals, poring over statistics, peering at stars, carving up household pets and pests indiscriminately, rigging up mazes of wire and tubing, and juggling with the fourth dimension. The motives that stir your enthusiasms are mostly beyond their ken. Forty years and more ago a track laborer on the right-of-way of the Nickel Plate Railway in Cleveland saw a man fussing with sets of mirrors in a way which struck his curiosity. The man didn't seem to be a surveyor or an inspector of permanent way. "What," he asked the trespasser, "are you up to here?" "Why, I am trying to measure the velocity of light." "Well, why should any one make such a fuss over a thing like that?" "Oh, because it is such corking good fun!" The trespasser was Michelson, and his fun lasted a lifetime. Corking good fun! How lightly the genius of optics summed up his ideals—the philosopher's thirst for truth, the artist's struggle for self-expression, the pioneer's wrestle with nature, the prospector's zest for discovery, the idealist's pursuit of supreme excellence—such corking good fun!

John Doe, as he rolls or strolls along the street, prides himself on being a great admirer of science. He is vaguely aware that science makes the water pure, keeps the sewers safe, keeps the current on tap in the wires, makes the telephone talk, tames the germs that pursue him, discovers medicines to kill

[1] Address at the Sigma Xi Initiation, Ohio State University, May 26, 1933.

them, puts the jazz on the air, and makes the family car reliable enough for the wife to run. He even reads of rocket ships to visit the moon, of frogs without fathers and of roosters made over into egg-laying hens. He wonders if it was Will Rogers who started all this fuss over comic rays and why Einstein can get folks so excited about his relatives.

John Doe isn't quite so cock-sure as he used to be that all this science is a good thing. This business of getting more bread with less sweat is all right in a way, but when it begins to destroy jobs, to produce more than folks can buy and to make your wife's relatives dependent on you for a living, it is getting a little too thick. Perhaps science is going too fast. That preacher over in England who wanted to call a halt on all this research stuff and on all new inventions for ten years wasn't so crazy after all. And then there are taxes—endless and back-breaking taxes. Didn't he just hear that it costs anywhere from 5 to 10 million dollars a year to run one of these universities, and the football team wasn't so hot at that? Better set some of these atom-busters and dog-carvers and guinea-pig tenders to working for a living and give the ordinary property owner a break.

No, John Doe is not much aware of being in your debt, and least of all perhaps for the ideas that control his habits of thought and life.

My purpose to-night is to discuss in simple outline some contributions which science has made to our every-day philosophy, to the idea patterns of the man in the street. To be modern means to believe in progress—that if life isn't getting better, at least it ought to be, that our children have a right to a better chance than we, that humanity will not inevitably repeat all its past errors, that civilization will consolidate and hold its gains. The Greeks, we are told, had a word for many of our supposedly advanced ideas, but I doubt if they had a word for progress. In ancient times it was believed that humanity was in a continuing or progressive state of decline or even decadence. The good days were in the legendary past. Each generation kept getting further away from the golden age. Religion looked backward wistfully to the happy garden where men were as gods. The longed-for Messiah was not to be an innovator, a discoverer, a creator—but a restorer of man's lost estate. It was a depressing doctrine, tinged with futility.

In the middle ages life was looked upon as a hard experience whose only reward was to be found in another world. Sainthood was to be the goal of striving, and there was little hope of a better state of life this side of the grave. Here and there a Roger Bacon caught gleams of progress, but they were mostly dim or fleeting. Truth was to be sought in the lore of the ancients. If you were curious about nature, you consulted Aristotle. The university was an elaborate debating society. Invention was a tedious matter of casual trial and error. The arts were passed on from generation to generation without significant change, so that the tools which first broke the soil of Jamestown and Plymouth might have been at home on the latifundia of Rome.

The birth of natural science brought a new conception, the optimistic conception that man could be in large degree the master of his fate, the hope that he need not fear nature, but could enlist her in his service. The long struggle of civilization for more bread with less sweat was suddenly changed from a losing fight to a series of brilliant triumphs. Men began to invent tools deliberately. Man, whom Thomas Carlyle rather sneeringly called "the tool-using animal," began to acquire a new dignity, as the only being in the whole order of nature who is able to overcome his own limitations and make nature his partner and not his tyrant.

Science not only taught man to believe in progress, but it taught him as well to believe that it could be achieved in cumulative effort. The ancients won their knowledge by placer mining; here a nugget, there another, washed out by a lone prospector. The modern man of research mines the hidden veins systematically and has learned to separate the finely dispersed gold from the baser bulk of human experience by experiment, analysis and verification. With the growth of systematic science, the dependence of mankind on rare and unpredictable genius began to decline. Science grows by accumulation. Its victories belong to the army of patient, often obscure investigators rather than to some rare Napoleon. Its ideal is that of removing the hazards of chance from the growth of knowledge and the advance of human well-being. What we have gained in the last two centuries has been due less to individual brilliance and inspiration than to the capacity which men have developed to work together in groups. It is this idea of progress through cumulative effort, progress by cooperation, progress which does not wait for some brilliant stroke, some lucky discovery, or the coming of some superman which is perhaps the chief contribution of science to social philosophy.

To natural science, with its ideal of cumulative and conserved progress, we may also credit the growth among men of a psychology of abundance, with its whole train of political and social consequences. Primitive man, with his instincts rooted in nomadic existence and branded by his incessant struggles against cold, hunger, pestilence, enemies and want in every form, would have thought the notion that mother earth could provide an abundance for billions of children utterly fantastic; like the old woman of the shoe, she already had so many she didn't know what to do. The ancients accepted slavery and aristocracy

naturally as the unescapable consequences of meager resources and scanty production. I can not think it a coincidence that the development of democratic ideals and institutions, of human hope in religion and social vision in ethics has come step by step with the growth of science and technology. These ideals are the political, economic and spiritual affirmation of the credo of human progress, based on a possible abundance for man in this world. How far we have moved from the faith of the ancients that stoicism in the face of want, of pestilence or war is the highest of virtues. Oriental and Occidental cultures find here their major plane of cleavage. Charles A. Beard, the historian, records his vivid impressions of the religions of India as natural expressions of the ideals of a people who have no hope of a square meal in this or any other world. If nature forbids the satisfaction of the most elemental of all wants, the longing for food, what greater boon can be sought than emancipation from all desire and from consciousness of one's self?

At opposite ends of the circle of fatalism lie the passivity of Asia and the dazzled optimism of the Victorian Age. Man's brilliant conquest of nature made the idea of progress seem an automatic principle. Social control over discovery, invention and industrial exploitation was unnecessary, in fact, almost profane. "Hands off! Let economic law take its course, and in time all would be well!" Would that human welfare were so simple, but we are finding that *laissez-faire* or rugged individualism break down in our larger crises where readjustments must be made at forced speed. The war made it tragically evident that progress is not inevitable.

If the war has brought to a climax changes in our social philosophy, the period since the war has brought sweeping changes in natural philosophy. Fifty years ago chemists and physicists were fairly confident that they had come upon the ultimate units in nature. These were atoms—minute, hard, indestructible, elastic, billiard balls of stuff, controlled by the same universal laws of gravitation which held the planets in their courses. Philosophers in ivory towers and simple men at their firesides began to build themselves pictures of the universe, not out of the figments of pure thought, but out of the very hard, solid atoms of the physicist and chemist. And quite a plausible picture it was that they built out of chance groupings of atoms.

Was it not Huxley, the great expounder of mechanism in nature who asserted that six monkeys, set to strum unintelligently on typewriters for untold millions of years, would be bound in time to produce all the books in the British Museum? In short, given time, every conceivable accident was bound to happen. And here was man, who had once dreamed of himself as the central figure in a drama of salvation on which all existence turned, reduced to a casual incident, just a chance arrangement of little billiard balls amid millions of suns and planets whirling in inconceivable space.

Scarcely had ordinary men settled down on the atom as the indivisible unit of nature with a machine theory of the cosmos in imminent prospect, when experiments suddenly broke through this supposedly adamant foundation into a new and magical world. Roentgen caught an accidental glimpse of it in 1895 and the Curies broke into it with more evident design in 1898. With a crash the entire solid, billiard-ball model of the cosmos collapsed. Explorers found themselves threading their way through the ruins into a wonderland more strange than even Alice had discovered, where the hard stuff of matter dissolves into impalpable radiation and where energy, whatever that may be, is turning itself into atoms and molecules. Here are transformations that seem to defy all predictions: anomalies which seem to hint of some caprice in the chain of causes and effects. Is energy merely another aspect of blind matter? Is it something wholly apart from the realm of the spirit? What physicist would dare assert it? The scientist who a short generation ago was shunning the "den of the metaphysician" has now moved in and taken possession. A curious day this—when certain biologists speak confidently of growing men to order in the laboratory if the need arises (note the saving clause) and certain psychologists profess their belief that they could mold the new-born babe at will to any pattern of conditioned responses—yet one can scarcely find a materialistic physicist. How interesting it would be to call Huxley and Spencer back from the shades to behold this new wonder.

And what shall we say of the overturn in our notions of time and space, of eternity and the infinite, of the ideal, the relative and the absolute. John Doe may think of modern mathematics as the fringe of insanity, but there is scarcely an idea in his head which it has not revolutionized. He has lost much of his sense of certainty, and gained in his respect for probability. The only inexorable certainty he can hold to is the certainty of ever-continuing change. If you can not live adventurously, you are only an onlooker in life's game. Max Planck, one of our major prophets, says: "Science does not mean contemplative rest in possession of sure knowledge." If John Doe wants contemplative rest, even on the vegetative level of intellectual existence, he will have to go back to the thirteenth century for it.

Volumes could be written on the revolution in sidewalk philosophy which has grown out of the generic concepts of organism and evolutionary development. John Doe's casual speech, without his being aware of it, is saturated with ideas based on genetic transmis-

sion, embryonic development, differentiation of structure and function, modification by environment, the influence of survival values, and progress through successive stages of conception, gestation, infancy, maturity and senescence. He not only applies these ideas to individuals; you may catch him any day applying them in a sweeping manner to communities, states, nations, races and whole civilizations. John Doe does not hesitate to ascribe personality traits to nations as well as to individuals. The Scotch are close, the Irish garrulous, the Dutch stubborn, the French polite, but not always sincere, the Germans plodding when at peace but savage in war. The individual as well is not merely the product of certain hereditary influences, he is the product of an intellectual and social climate as well. Whether a given person is a monk, a robber baron, a crusader, an explorer, a pirate, a poet, a pioneer, a missionary, an inventor or a research worker is not wholly a matter of chromosomes and early nurture, it is also a matter of the century—or even the decade—in which he lives.

Perhaps no phase of modern behavior is more characteristic than that of specialization. Here the parenthood of science is clear and unmistakable. Specialization among the ancients was primarily a differentiation of skill. The oldest recorded craft appears to be that of metal worker. Before priest, lawgiver, healer or soldier was Tubal-Cain—"the instructor of every artificer in brass and iron," only six generations from Adam. Specialization of function is also a fairly old idea. Plato elaborated it in his "Republic," but no one can imagine Plato or Aristotle proposing a society based on specialization of knowledge. Even as late as the sixteenth century, Francis Bacon, who by profession was Lord Chancellor of England, was able to claim all knowledge as his sphere. Science, on the other hand, owes much of its fertility to the principle of the division of labor. Effective science did not begin until men made the winning of knowledge their distinctive business or profession. Knowledge multiplied amazingly when an army of specialists began to break it up into ever smaller and smaller fragments in order to pursue it the more intensively.

Philosophy in all ages has sought for unity of knowledge, science for diversity. The contrast between the specialism of science and the generalism of philosophy is the theme of a structurally perfect epigram—that science is a means of learning more and more about less and less until one knows everything about nothing; while philosophy is a way of learning less and less about more and more until one knows nothing about everything. In the contest between these two principles the battle has gone heavily of late in favor of science. Every branch of learning has craved a share in the prestige of science. History, economics, sociology, politics, psychology, linguistics, education and even theology deserted the camp of the philosophers almost in a body, to seek admission to the ranks of science. Of late it has seemed that it is not the arms, the uniform, the equipment nor the tactics which distinguish the soldiers of science. One only needs to utter the right password to enter the lines and that word is "objectivity." Verily, we use the word science to mean so many things nowadays that we no longer have any word to mean science. Trust John Doe to destroy all distinctions of meaning from any word which acquires prestige values.

The age of specialization leads inevitably to the age of the expert. The ideal man of a pioneer society was the self-reliant, self-sufficient individualist. In the society which framed the American Declaration of Independence, and later the Federal Constitution there was little to mark one man off from another except native intelligence, natural energy, property ownership and personal cultivation. Ten in eleven were living on the soil, with all the highly localized interests of a rural society. Men who expect as a matter of course to be farmer, carpenter, mason, blacksmith and, on occasion, physician, magistrate and legislator as well, find it easy to admire the versatile amateur and to look with disfavor on the specialist, even to suspect him of being a sharper, bent on using his superior knowledge to do the common man out of his rights. The fathers, or at least those who followed Thomas Jefferson, had a profound faith in the collective wisdom of common men. Democracy was expected to transcend in some way the limitations of the individuals who composed it. Patriarchal societies from Old Testament days down have held in special reverence the sort of wisdom which distils out of common experience. This was assumed to accumulate with age and to invest the old with special sagacity in counsel.

Now that the new deal has begun to emerge, it seems that science, with its emphasis on specialization and on knowledge acquired by persistent inquiry, has been undermining a lot of traditional thinking about natural self-sufficiency, collective intelligence and automatic wisdom. Government has been the last sector to capitulate to the specialist. A few years ago John Purroy Mitchell was chosen mayor of New York in a great wave of reform. At once he surrounded himself with the best experts on the various phases of city administration and gave the city an unexampled taste of efficient government. When the next election came, the voters pitched him out, lock, stock and barrel. "Who wants to be governed by a bunch of ——— experts," shouted John Does by the thousand. "We want to be run by folks like ourselves." But now that the brain trust seems firmly seated in the second line of responsibility at Washington, the

old idea that any honest man is good enough to govern seems to be on its last legs.

In the proposed measure to invest the trade associations with quasi-official responsibilities one sees the emergence of a functional type of government, which may in time overshadow the old principle of geographical representation which reflected the localized interests of a rural society. Let the men of science who have labored obscurely in government bureaus take courage. The day of the expert shows signs of dawn.

The total effect of scientific inquiry on the man in the street has been to heighten his sense of individual insignificance. How far away and long ago the voice of the shepherd-psalmist:

> When I consider thy heavens, the work of thy fingers, the moon and the stars which thou hast ordained, what is man that thou art mindful of him and the son of man that thou visitest him? For thou hast made him but little lower than God and crownest him with glory and honor.

When the astronomer of to-day gets through with man, he can think of himself only as an animated mite, lost in limitless space on a speck of cosmic dust.

With this growing sense of individual insignificance has come a decline of interest in personal salvation and personal immortality. But as the concern to save one's own soul has lessened, the desire for social salvation and for a share in the immortality of the human life stream has grown apace. Humanity is still crying, "What shall I do to be saved?" The world scene beyond our own borders serves only to heighten the sense of revolutionary tension—Russia in a fever of social transformation, Italy scorning individual freedom for the discipline of the state, Germany groping for the pillars like a blind Samson, Japan expanding by the sword, China in chaos, halting between republicanism and communism, India in revolt against not only the rule but also the civilization of the western world, and everywhere a creeping paralysis in economic life.

Where may society look for salvation? Dynasties have crumbled and democracy fumbles its way by trial and error. Dictatorship, whether of an individual or a class, is fraught with terrible risks. Crises bring an instinctive craving for a leader, for some Moses to guide mankind through the wilderness. Men begin to despair of thinking and working their way through their problems; they long to have the seas rolled back, manna sent and water brought forth from rocks. They crave the pillar of cloud and of fire. Send us, they pray, some superman who can solve our problems by sheer insight.

The seer's vision may penetrate the very depths of the human heart, but the ills of society are too impersonal and too complex. May I suggest that, grave as our need of personal leadership is, our need of knowledge is even graver. How can there be lack of knowledge, in the face of the mastery of nature we have won in the last century? Perhaps the triumphs of physical science and our faith in the social gains from its application have made us overconfident. Have we not built up a social structure far beyond the limits of our social intelligence? Have not the materials and members of a simpler society proved unequal to the stresses of a technological era? Why should we seek some political genius or some spiritual prophet to solve a crisis whose problems are essentially those of social architecture and engineering?

The sure and permanent gains mankind has made in the last three centuries have come through patient and cumulative investigation. This ideal of progress through understanding, progress through cumulative effort, progress by cooperation, progress which does not wait for some brilliant stroke, some lucky discovery, some prophet's insight or the leadership of some superman, has been the chief gift of science to social philosophy.

Our knowledge of men and of social institutions stands to-day where our knowledge of material nature stood two centuries back. We may be compelled to retrace our steps for a time to a simpler organization of society. We may, for a time, need to forego some of the material benefits which science and technology are amply able to provide. If we are to enjoy these gains with any security, it is urgent beyond all else that our knowledge of the human and social sciences be brought abreast of our material development.

Since the end of the American frontier, school, college and university have been our guarantee of an open door of individual opportunity. This door must be kept open if democracy is to survive. The university is now our frontier, but it has an even more significant mission. As individual leadership grows more inadequate for our social problems, we must depend more on institutional leadership. The university must lead the state. It is our only seat of open-minded, disinterested, cooperative effort. In it are enshrined the ideals of inquiry and of understanding. Before all else, it stands for the leadership of intelligence, rather than blind emotion. Science has been called a false Messiah, whereas it is no Messiah at all. It does not promise to lead men back through the darkness to a golden age that is lost; instead it offers them light, light that all may share, that they may walk by sight and not by faith alone, into the future unafraid.

If in this hour of crisis we weaken the university and let her light grow dim, we do so at the peril of our civilization.

SCIENTIFIC EVENTS

SURVEY OF THE MUSEUMS AND ART GALLERIES OF GREAT BRITAIN

A CORRESPONDENT of *The Christian Science Monitor* writes from London that, for the first time, the art resources of the British Empire have been catalogued. This has been accomplished through a survey of museums and art galleries which has been in progress since 1931 and which has just appeared in the form of a final report. The work has been carried on with the aid of a gift of £8,000 from the Carnegie Corporation of New York.

In the opinion of the secretary of the survey, S. F. Markham, the five most progressive museums in the entire empire, "taking into account building, finances, equipment, staff, technique, as well as wealth of collections," are the Science Museum, London; the Royal Ontario Museum, Toronto; the Auckland War Memorial Museum, New Zealand; the National Museum of Wales, Cardiff, and the Royal Scottish Museum, Edinburgh. On the other hand, the places of considerable population where art gallery and museum provision is of least adequacy and efficiency are Chesterfield, Croydon, Willesden, South Shields and Wigan (all England); Winnipeg, Manitoba; London, Ontario, and Newcastle, Australia.

New Zealand appears to be one of the most progressive sections of the empire in its enthusiasm for promoting the welfare of its galleries and museums. While South Africa and Canada spend no more than 1½d. a head a year on their art resources, New Zealand expends 3½d. a head. Throughout the empire the total annual expenditure on art galleries and museums is £1,700,000. Great Britain's annual expenditure a head is 7½d. The progressive attitude displayed in cultural matters by New Zealand is ascribed to the determination of the people not to be satisfied with the second-rate. Its high position is further indicated in the statistics relating to the provision made by individual towns and cities for art accommodation.

The finest collections are naturally to be found in London and in the national galleries in the British Isles. But apart from these it is thought that the best collection is that of the Royal Ontario Museum, Toronto, which not only has an admirable selection of the works of Canadian artists, but also a world-famous collection of Chinese antiquities. There are good collections at Melbourne, Sydney, Adelaide and Ottawa.

The need is emphasized for closer cooperation between the museums and galleries of the various parts of the empire. The suggestion is being made that, by an alteration in the present state of the law, the National Gallery, London, might radically assist the Dominions in their cultural efforts.

THE ARBORETUM OF THE UNIVERSITY OF WISCONSIN

GEORGE WILLIAM LONGENECKER, professor of horticulture at the University of Wisconsin, has been appointed executive director of the arboretum by the board of regents.

The arboretum, one of a half dozen or so of its kind in the entire country, was established last fall and at present contains 430 acres of land on the outskirts of Madison, bordering Lake Wingra. The land has been obtained by gift or purchase, with funds made available from the Tripp estate. No state-appropriated funds whatever have been used on the project.

Aldo Leopold, widely known Wisconsin conservationist, has been appointed professor of wild life management and research director. Funds for the development of the arboretum as an outdoor experimental laboratory, in which research work on various problems facing state reforestation and wild life propagation and conservation work can be carried on by the university, were made possible by a grant of $8,000 by the Wisconsin Alumni Research Foundation.

Professor Longenecker has been connected with the university for seven years. When development of the arboretum was started last summer, he superintended the planting of about 13,000 Norway and white pines and about 2,000 white spruce trees. He also had charge of the building of a roadway through the large tract of land, and directed the rock work around the springs in the area.

The arboretum gives the university and the state an opportunity for experimentation in reforestation and in the propagation of wild life, in the opinion of members of the University Arboretum Committee, under whose direction the development of the land for the best interests of the people of the state is carried out.

The committee, composed of many university and state officials and private citizens, was appointed by President Glenn Frank last fall. E. M. Gilbert, professor of botany, is chairman.

ATTENDANCE AT THE FIELD MUSEUM OF NATURAL HISTORY

MORE than three million persons have visited the Field Museum of Natural History during 1933 to date, making an attendance record, according to a statement made by Stephen C. Simms, director of the museum, which exceeds any attained by a museum in the United States and probably exceeding the highest figure reached by such an institution. The best available comparative statistics indicate that the previous highest attendance for any similar institution was

something over 2,000,000 during an entire year, and not more than two American museums have reached that mark.

The exact number of visitors received at Field Museum from January 1 to November 12, inclusive, is 3,208,414. This represents an increase of 76 per cent. over the attendance for the entire twelve months of 1932, which was 1,824,202, and, with 49 more days of 1933 still to be added, the record will be even greater by the end of the year.

While, naturally, much of the increase may be attributed to the museum's proximity to the grounds of A Century of Progress, Mr. Simms points out that there has also been a large normal increase, continuing the steady upward tendency which has been noted year after year. This is shown by the fact that from January 1 to May 26, 1933, inclusive (the period prior to the opening of the exposition), attendance at the museum was 707,245, as compared with the 549,407 registered between the same two dates of 1932. Thus, even the preexposition period of 1933 shows an increase of 157,838, or more than 28 per cent., over 1932.

Of the more than 3,200,000 persons visiting the museum this year, 209,624, or only about six and one half per cent., paid the 25-cent admission fee charged on Mondays, Tuesdays, Wednesdays and Fridays; all the rest, numbering 2,998,790, or ninety-three and one half per cent., either came on Thursdays, Saturdays and Sundays when admission is free, or belonged to classifications such as children, teachers and students who are admitted free on all days.

According to Mr. Simms, these figures demonstrate the extent to which the museum has subordinated possibilities of increased revenue to the greater objective of providing service to the public on the widest possible scale. They show that the museum is fulfilling its mission as a great educational institution, and that full advantage of its tremendous resources for the dissemination of scientific knowledge is being taken and appreciated by citizens of Chicago and visitors to the city.

Some high attendance records for individual days have been made during 1933. There were two days on each of which the attendance was in excess of 65,000 persons, and seven days when attendance exceeded 50,000.

ANNUAL MEETING OF THE HIGHWAY RESEARCH BOARD

THE annual meeting of the Highway Research Board will be held in Washington in the building of the National Academy of Sciences on December 7 and 8. The subjects to be considered are as follows:

Finance

Further Studies of Taxation and Expenditures.

Highway Transportation Economics

General Principles for the Evaluation of Highway Systems.
Physical Valuation of Highways.
Use of Traffic Surveys in Evaluation of Highways.
Methods for Determining Highway Transportation Costs.
Economy of Highway Improvement.
Wind Resistance of Motor Vehicles.
Relations between Tires, Surfaces and Skidding.
Motor Vehicle Tractive Resistance.

Highway Design

Roadside Development.
Research in Highway Lighting.
Use of High Elastic Limit Steel as Concrete Reinforcement.
Portland Cement Macadam Pavement Experiments.

Materials and Construction

Relation between Composition of Cement and Durability of Concrete.
Curing of Concrete Pavements.
Effects of Calcium Chloride in Concrete.
Fundamental Research on Durability of Aggregates.
Fillers and Cushion Courses for Brick and Block Pavements.

Maintenance

Treatment of Icy Pavements.
Maintenance Costs.
Crack and Joint Fillers.
Snow Control Experiments.

Highway Traffic and Safety

Studies of Traffic Behavior under Various Conditions, at Seventeenth Street and Constitution Avenue, Washington, D. C.
Rules of the Road.
Studies of Prevailing Speeds on Rural Highways.
Analysis of Traffic by Moving Pictures.
Alcohol and Motor Vehicle Drivers.
Traffic Survey Methods and Forms.

EXCHANGE PROFESSORSHIPS

THE Massachusetts Institute of Technology has inaugurated a general plan for exchange of professors with other educational institutions and research laboratories, according to an announcement by President Karl T. Compton. This is the outgrowth of a suggestion made by Professor D. C. Jackson, head of the department of electrical engineering, in a paper before the Society for the Promotion of Engineering Education in Chicago last summer.

The plan provides for such an exchange arrangement each year for one member of the staff of each of the departments of study in the institute, embracing the fields of science, engineering, architecture and humanities. The nominations to these exchange professorships will be made by the heads or deans of corresponding departments in the cooperating institutions. Each institution will continue to pay the regular salary of its professor, while on leave. In

addition it is proposed to add a modest supplement to the salary of each of the professors involved in the exchanges, in view of special expenses of travel and of temporary living arrangements. Such exchange arrangements may be made with any educational institution in this country or abroad, and also with industrial research laboratories.

The purpose of the plan is to broaden the experience, acquaintance and educational outlook of the men, and to disseminate quickly and widely the best educational methods as they develop in various individual institutions. This exchange will be of mutual benefit to the cooperating institutions, since each may take and use whatever of advantage it learns through this personal contact with the other. Furthermore the plan will tend to overcome a certain tendency in institutions to become "ingrown" or "academic" by providing new contacts with outside personalities and ideas.

In general it is planned to limit appointments to men who still have years of active service ahead of them, yet who have already achieved some distinction. The first appointments will be made in the next academic year, 1934–35.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

THE Elisha Mitchell Scientific Society of the University of North Carolina celebrated on November 14 at Chapel Hill the fiftieth anniversary of its founding. Dr. Archibald Henderson, Kenan professor of mathematics in the university, reviewed the history and achievements of the society, and Dr. W. C. Coker, Kenan professor of botany, told of its publications and exchanges. The visiting speaker of the occasion was Dr. Ivey F. Lewis, Miller professor of biology in the University of Virginia. Dr. Lewis spoke on "Adaptation: the Fourth Property of Protoplasm."

The society was founded in 1883 by five members of the university faculty, who, though averaging scarcely twenty-five years of age at the time, possessed an indefatigable zeal for research and a firm determination to further the understanding of natural phenomena. They were R. H. Graves, professor of mathematics; J. A. Holmes, professor of biology and geology, who, after a subsequent period of service as state geologist, was instrumental in establishing the U. S. Bureau of Mines and who became its first director; W. B. Phillips, chemist, and later geologist of the State of Texas and president of the Colorado School of Mines; J. W. Gore, professor of physics and later dean of the college, and F. P. Venable, for fifty years professor of chemistry in the university, its president from 1900 to 1914, and president of the American Chemical Society in 1905.

The society was named by its founders in honor of Dr. Elisha Mitchell, a graduate of Yale College in 1813, who occupied various chairs of natural science in the university from 1817 until the time of his death. Dr. Mitchell lost his life on one of his numerous excursions to the mountains of western North Carolina for the purpose of conducting stratigraphic and altimetric studies. Detained by a thunder storm and overtaken by darkness on June 27, 1857, as he was descending the highest peak in eastern America (subsequently named Mt. Mitchell in his honor), he plunged precipitously over a cliff to his death.

The founders established the *Journal of the Elisha Mitchell Scientific Society* as a means of publishing the society's contributions to science. The journal, now in its forty-ninth volume, has enjoyed a continuous existence since the appearance of the first volume in 1884. It has published to date (1933) 8,530 pages of text and 909 plates, dealing largely with the biological and physical resources of the South. Nearly four hundred current exchanges, among which thirty-six foreign countries are represented, attest to the value of the journal in contributing to knowledge and to the significant part that it has played in building up the periodical collection of the university library.—X.

ROYAL SOCIETY AWARDS

THE King of England has approved of the following awards this year by the president and council of the Royal Society in respect of the two Royal Medals:

A Royal Medal to Professor G. I. Taylor, F.R.S., for his mathematical work in physics, geophysics and aerodynamics.

A Royal Medal to Mr. P. P. Laidlaw, F.R.S., for his work on diseases due to viruses, including that on the cause and prevention of distemper in dogs.

The following awards of medals have also been made by the president and council:

The Copley Medal to Professor Theobald Smith, of Princeton, for his original research and observation on diseases of animals and man.

The Davy Medal to Dr. W. H. Mills for his researches in organic chemistry, and for his work on the syntheses and properties of the cyanine dyes, and more especially for his investigation of novel types of asymmetric molecules.

The Hughes Medal to Professor E. V. Appleton for his researches into the effect of the Heaviside layer upon the transmission of wireless signals.

The following is a list of those recommended by the president and council for election to the council of the society at the anniversary meeting on November 30:

Sir Frederick Hopkins, *president;* Sir Henry Lyons, *treasurer;* Sir Henry Dale and Sir Frank Smith, *secretaries,* and Lord Rayleigh, *foreign secretary.*

Other members of council.—Dr. E. J. Butler, Dr. W. T. Calman, Professor C. H. Desch, Professor T. R. Elliott, Professor A. V. Hill, Mr. C. N. Hinshelwood, Professor A. Hutchinson, Dr. H. S. Jones, Professor J. C. McLennan, Dr. F. H. A. Marshall, Sir Charles Martin, Professor E. Mellanby, Professor R. Robinson, Mr. H. T. Tizard, Professor E. T. Whittaker and Mr. G. U. Yule.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM H. WELCH, president of the Board of Scientific Directors of the Rockefeller Institute since the foundation of the institute in 1901, has retired and has been succeeded by Dr. Theobald Smith. The trustees of the institute have elected Dr. Welch member emeritus of the board, a new office created in order to honor him.

DR. GEORGE D. BIRKHOFF, professor of mathematics at Harvard University, received an honorary degree from the University of Poitiers, France, at the recent quincentenary celebration at the university.

DR. COLIN G. FINK, head of the division of electrochemistry at Columbia University, has been awarded the Perkin Medal of the New York section of the Society of Chemical Industry for 1934, in recognition of his contributions to metallurgy and electrochemistry. Presentation of the medal will be made at a meeting in New York City early in January.

A CHEMICAL INDUSTRY MEDAL, to be awarded annually for a valuable application of chemical research to industry, has been established by the American section of the Society of Chemical Industry, to take the place of the Grasselli Medal, now discontinued. The first award was made to James G. Vail, vice-president and chemical director of the Philadelphia Quartz Company. The presentation was made by Professor Marston T. Bogert, of Columbia University, at a joint meeting held recently at the Chemists' Club, New York, of the American Chemical Society, the Electrochemical Society and the Société de Chimie Industrielle. Professor Walter T. Taggart, of the University of Pennsylvania, described Mr. Vail's work, and the latter delivered an address on the many new and varied applications of water glass.

DR. FREDERICK E. TURNEAURE, dean of the college of engineering at the University of Wisconsin, was recently made an honorary member of the American Society of Civil Engineers, by vote of the directors of the society. There are nineteen honorary members in a total membership of over fifteen thousand.

THE *Journal* of the American Medical Association reports that Dr. F. G. Banting, professor of medical research in the University of Toronto, has been admitted to honorary fellowship in the Royal College of Surgeons. He was already a member of the college. He was welcomed by the president, Sir Holburt Waring, and signed the roll in the presence of the council. It is three years since Dr. Banting was nominated for the fellowship, but this was the first opportunity to confer it on him.

DR. FRIEDRICH VON MÜLLER, professor of internal medicine at Munich, has recently celebrated his seventy-fifth birthday.

THE Goethe Medal of the German Empire has been awarded to Dr. Albrecht Penck, professor of geography at the University of Berlin.

DR. ROSS V. PATTERSON, dean of Jefferson Medical College, Philadelphia, was elected president of the Association of American Medical Colleges at the annual meeting which was held in Rochester and Minneapolis, from October 30 to November 1. Dr. Charles W. Poynter, Omaha, was elected vice-president and Dr. Fred C. Zapffe, Chicago, was reelected secretary. Nashville was selected as the place for the meeting in October, 1934.

M. LEMOINE, director of the National Museum of Natural History at Paris, has been elected president of the Association of Museum Curators of France.

DR. G. E. HARMON, associate professor of hygiene and vital statistics of the School of Medicine of Western Reserve University, was elected chairman of the section of vital statistics of the American Public Health Association at the recent meeting in Indianapolis.

DR. FREDERICK G. COTTRELL, of Washington, has been appointed chief consulting chemist of the Tennessee Valley Authority. Dr. Cottrell for some time has directed the fertilizer experiments for the authority, which has set aside $4,000,000 for construction of fertilizer works at Muscle Shoals.

E. C. CRITTENDEN, chief of the Division of Electricity of the U. S. Bureau of Standards, has been appointed assistant director of the bureau in charge of research and testing, to fill the vacancy created by the appointment of Dr. Lyman J. Briggs to the directorship of the bureau. Mr. Crittenden has been connected with the Bureau of Standards since July 1, 1909.

AT the Pennsylvania State College, Dr. F. F. Lininger, professor of agricultural economics and agricultural economist, has been granted leave of absence

from August 7 to February 7, 1934, and from June 1 to 30, for the purpose of participating in a study of the administration of the Agricultural Adjustment Act to be made by the Brookings Institution of Washington, D. C.

DR. ROBERT V. ALLISON, soils specialist, who has been in charge of the Florida Everglades Station, has been temporarily appointed senior soil conservationist in the Bureau of Chemistry and Soils to take over the planning and directing of investigations at the ten erosion stations of the U. S. Department of Agriculture. Dr. Allison will take charge of this work during the absence of H. H. Bennett, who has been loaned to the Department of the Interior to direct a large-scale demonstrational program under allotment of $5,000,000 from the Public Works Administration.

FERDINAND W. HAASIS has been temporarily appointed under NRA funds as physiologist to study windbreaks and erosion control at the Great Plains Field Station, Cheyenne, Wyoming, effective on December 1.

PROFESSOR HERBERT OSBORN, of the Ohio State University, has donated his collections of Hemiptera to the university, and the trustees in accepting the gift have provided a curator of insect collections in the department of zoology and entomology to assure the permanent preservation of these and other collections belonging to the institution. Mr. J. N. Knull, formerly with the Pennsylvania Bureau of Plant Industry, has been secured as curator and will take up the work in January. Dr. Osborn's collection is extensive, representing material which he has collected from his boyhood up to the present. It is rich in type material, especially in the family of Cicadellidae.

JOSEPH M. VIAL has been appointed specialist in animal husbandry by President Raymond A. Pearson, of the University of Maryland. Mr. Vial comes from La Grange, Illinois, and fills the vacancy created when Kenneth A. Clark resigned to become manager of a number of farms in Frederick County.

G. W. FERNER, who was recently granted the J. T. Baker fellowship in analytical chemistry, Midwest Division, has started work at Purdue University under the direction of M. G. Mellon.

THE trustees of the Ray Lankester Fund have elected Professor N. J. Berrill, associate professor of zoology at McGill University, Montreal, to be the Ray Lankester investigator at the Marine Biological Laboratory, Plymouth, from June 1, 1934. The subject of Dr. Berrill's research will be metamorphosis in ascidians and regeneration in sabellids.

THE first award of the Andrew Balfour studentship at the London School of Hygiene and Tropical Medicine has been made to G. M. Balfour, who is taking the course of study for the diploma in Tropical Medicine and Hygiene.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the year 1933–34: Dr. A. G. Winn, a British fellowship of £300, tenable for two years, at University College, London; Dr. N. W. H. Addink, a Netherland fellowship of £300, at the University of Cambridge, and Dr. J. Smittenberg, a Netherland fellowship of £300, at the University of Bristol. The trustees have renewed the following fellowships for the same year: Dr. J. M. Albareda, Spanish fellow, Rothamsted Experimental Station, Harpenden; Dr. Walter Cawood, British fellow, the University of Leeds, and Dr. John MacArthur, Glasgow fellow, the Royal Institution, London.

RALPH F. NIELSON, for the past three years instructor in chemistry at the Kansas State College, has sailed for Copenhagen, Denmark, where he will engage in chemical research under Professor J. N. Brønsted at the Institute of Physical Chemistry of the University of Copenhagen.

DR. MARTIN L. BONAR, head of the department of pharmacology of the school of medicine of West Virginia University, is spending three months in the Balkan states making a survey for the Near East Foundation.

PROFESSOR HOWARD Y. MCCLUSKY, of the University of Michigan, is on leave of absence this semester. He plans to spend his time in England and on the Continent, where he will visit psychological clinics.

EARL K. FISCHER, who for the past three years has held a Julius Stieglitz research fellowship at the University of Chicago, working with Professor W. D. Harkins in the field of colloid chemistry, is now employed as research chemist for the United Color and Pigment Company, Newark, N. J.

PROFESSOR OTTO STERN and Professor I. Estermann, of Hamburg, recently joined the staff of the Carnegie Institute of Technology at Pittsburgh, not the University of Pittsburgh, as was erroneously stated in SCIENCE for October 20.

DR. ELMER V. MCCOLLUM, professor of biochemistry at the Johns Hopkins University School of Hygiene and Public Health, on November 16 gave a lecture under the auspices of the Council on Dairy and Food of Connecticut on "Present Trends in Nutrition."

DR. O. R. MCCOY, of the School of Medicine of the University of Rochester, lectured on November 14 before the departments of medical zoology of the School of Hygiene and Public Health of the Johns

Hopkins University on "Immunity to Trichina Infection."

THE two hundred and fifty-fifth meeting of the Washington Academy of Sciences was held at the National Museum, Washington, on November 16, when the Rev. Dr. G. Lemaître, professor of physics in the University of Louvain and lecturer at the Catholic University of America, delivered an address on "The Expanding Universe."

PROFESSOR DR. OTHENIO ABEL, of the University of Vienna, will give a course of three lectures on "Paleobiology and Evolution" at University College, London, on November 24, 27 and 29.

THE Sigma Xi Club of the University of Denver held its first meeting for the year on October 20, under the leadership of Dr. Thomas Garth, *president,* and Dr. Earl Engle, *secretary-treasurer.* The 1933–34 program contains three lectures by outside speakers—Dr. Edward Jackson on "The Evolution of the Eye," Dr. E. R. Mugrage on "Human Blood Groups" and Dr. Maurice Rees, dean of the University of Colorado Medical School, on "Developments in Medical Education." Dr. E. B. Renaud, professor of anthropology at the university, will give an illustrated talk on "Old and New World Cultures," and Dr. Ira Cutler, of the department of zoology, will speak on "Birds of Colorado." The other meetings will be given over to reports on the research of graduate students and instructors in the science departments.

THE eleventh annual series of the Aldred Lectures of the Massachusetts Institute of Technology have been announced. In the first lecture of the series, on November 17, C. M. Ripley, of the General Electric Company, described "The Next Great Boom." Dr. A. E. Kennelly, professor emeritus of the Massachusetts Institute of Technology and Harvard University, on December 8, will speak on "The Relations of Engineering to Our Modern World." "The Cultivation of Judgment" will be analyzed by E. C. Mayo, president of the Gorham Manufacturing Company of Providence, in the third lecture on January 19. Dr. Harlow Shapley, director of the Harvard Observatory and member of the corporation of the institute, on February 16 will give an illustrated address on "Engineering Problems and Practises in the Construction of Galaxies." Concluding the series on March 16 will be a lecture by R. E. Flanders, president of the Jones and Lamson Machine Company, on "The Future of Business Enterprise."

THE Cameron Prize Lecture at the University of Edinburgh was delivered on October 6 by Dr. George F. Dick, professor of medicine at the University of Chicago. The Cameron Prize, founded in 1878 by the late Dr. Andrew Robertson Cameron, is awarded each year for an important contribution to practical therapeutics made during the preceding five years. This year it has been divided equally between Dr. George F. Dick and his wife, Dr. Gladys H. Dick, for their joint work on the cause, prevention and cure of scarlet fever.

FRIENDS of the late Professor U. S. Grant have created a fund to commemorate his distinguished services as a geologist and teacher by a series of lectures on some phase of geology, to be given at Northwestern University. The first series was given by Dr. W. H. Collins, director of the Geological Survey of Canada, on November 21, 22 and 23. The subjects of the lectures are "The Economic Future of Northern Canada," "Major Correlational Problems of the Great Lakes Region" and "The Sudbury Mining Field."

THE Sixth International Congress of Botany will meet at Amsterdam from September 2 to 7, 1935. It was originally planned to hold the congress in September of the present year.

THE Tokyo correspondent of the London *Times* announces a gift of 30,000,000 yen (£3,000,000 at par) to establish a foundation for public purposes from the Mitsui family, through which cultural and welfare institutions in town and country are to be supported, but the first place is to be given to scientific research and technical experiment. The Mitsui family, the wealthiest in Japan, are the owners, after three centuries of trade, of one of the largest business aggregations in the world, including trading, banking, mining and insurance corporations. The object, according to Seishin Ikeda, the present managing director, is to develop essential industries, such as aeronautics, where private enterprise is insufficient. During the recent terrorist outbreaks, according to the *Times,* the Mitsuis with other capitalists were denounced by patriotic agitators and Baron Dan, the managing director, was assassinated.

DISCUSSION

PALESTINE, GREAT NATURAL LABORATORY OF THE EAST

FOR the biologist, Palestine offers a singularly favorable field of research. The flora and fauna of the Mediterranean region meet in this land with those of the great desert belt that stretches from Morocco to Turkestan. In the Jordan Valley, tropical influences are to be found. Only a few hundred

kilometers separate the snow-covered slopes of Mount Hermon, in the Lebanon, from the burning tropical sands of the deserts. It is obvious that with such sudden transitions, the influence of external factors on the distribution of living organisms can be investigated much better than at many other places.

So far as concerns botany, the first task has in the main already been fulfilled. Based upon the comprehensive herbarium of the Hebrew University at Jerusalem, a handbook of Palestinian flora was recently issued in the Hebrew language (an English translation is in preparation). This book treats extensively of the flower plants of Palestine and their distribution. Their scope is remarkable. On a short excursion from Jerusalem to the Dead Sea, one passes through six different biological zones, and very frequently the northern slope of a hill shows quite a different flora and fauna than the southern slope. The ridge of the Mount of Olives, where the university is situated, is in itself the borderline between Mediterranean and desert regions.

The recently opened botanical garden at the university has been set the task of reproducing the ancient wood growths of the Palestinian hillsides in their virgin and pristine form. Its various sections will show the gradual deterioration of the once mighty cedars of Lebanon and other luxuriant growths mentioned in the Bible to the barren wilderness that is practically all that remains for the modern visitor to see.

In the dry regions of Palestine, the water metabolism of the plants is the center of interest in studies of plant physiology. But scientists are still at the beginning of their researches in Palestine, and may yet encounter surprises, as was the case last winter when it suddenly became evident that the first winter storms had a far larger influence on the evaporation of plants than even the hot and dry desert winds in springtime.

A special attraction for visitors to Jerusalem is the Museum of Biblical Botany and Palestinian Plant-Lore at the Hebrew University. The floral prototype of the menorah (seven-branched candelabrum used in synagogues since the days of the first Temple) is to be found there, together with the rose of Sharon and the lily of the field, in all their different stages of botanical development, as well as many other plants mentioned in the Scriptures.

In the field of zoology, the complete survey of Palestinian fauna is still remote. Present knowledge is confined to vertebrates, mollusks and several insect groups, but their conditions of life and habits are almost unknown. Careful observations during the year over small selected areas, from the dunes around the seashore at Tel-Aviv to the Jordan River near Jericho, yielded for the first time valuable data on the animal associations of those areas and their distribution during the year and the day. Some years ago a monograph was devoted to the Solomonic ant. A monograph on the Palestinian locust was also recently completed. Special attention was devoted to the migratory locust (*Schistocera gregaria*), whose invasions of the Holy Land were mentioned in the Bible. To a large extent, the department of zoology of the Hebrew University has been successful in solving the riddle of the mass propagation of this insect.

Much attention was also paid to other insects injurious to agriculture in this country. Elaborate investigation in the field was carried on in the biology and methods of combatting some of the citrus insects —most important in the development of the chief crops of Palestine. With the assistance of a financial grant by the British Empire Marketing Board, a branch of the British Department of Overseas Trade, research was conducted into the influence of plant nutrition on certain injurious insects preying on oranges. The investigations may eventually lead to new developments in methods of combatting injurious insects.

The scientific problem upon which the work of the zoological laboratory in Palestine centers is that of laying the foundation for a general theory of animal population. Hydrobiological studies have also been started; their general importance is illustrated by the fact that practically nothing is known about life in subtropical waters. There is a museum at the Hebrew University which now is furnishing the beginnings of a scientific and demonstrational collection of Palestinian animals.

Geology, too, contributes its share to the solution of these biological problems. It makes possible an analysis of the climate of Palestine from the days since it first emerged from the sea. It is only on such a basis that the history of the population of this country by plants, animals and mankind, can be fully understood. In addition to the geological exploration of the country, the problems of water supply and other practical problems (phosphate resources and oil-wells), as for instance in the Jordan River basin, afford a unique opportunity for the study of general tectonic problems.

There are other innumerable scientific tasks attracting the attention of scientists, both in the Near East and, indeed, throughout the whole civilized world. Numerous problems linked with the development of Palestine are attracting scientists interested in working in the country, keeping in view the aim of re-establishing and reawakening a land, backward for centuries, almost devastated of its one-time glory. There are untold opportunities, too, for the scientist

working for the advancement of knowledge in a country whose opportunities for research are as varied as its climate and its contours.

FRITZ S. BODENHEIMER

HEBREW UNIVERSITY
JERUSALEM, PALESTINE

OCCURRENCE OF FRESH-WATER MEDUSAE IN MICHIGAN[1]

ON September 9, 1933, medusae were found for the first time in the vicinity of Ann Arbor. This is apparently the first record of their occurrence in Michigan. They were first found by a fisherman in Barton Pond, a part of the Huron River, in an area where the current had evidently thrown them into a backwater where they had assembled in considerable numbers. On September 17, the upper limit of distribution was located about one mile further upstream. In this area the water was stagnant and the medusae were swimming in enormous numbers. All stages of development from early gonad to fully matured individuals were present. As far as we have been able to determine, all individuals were females. Size ranged from one quarter to one inch in expanded phase. On September 18, a bright sunny day, large numbers were collected. On September 19 and 20, both being dark stormy days, not a single specimen could be located.

A diligent search of the vegetation, bogs and rocks has so far failed to locate the hydranth stage.

This medusa is apparently *Craspidacusta sowerbyi*, which has been reported many times in the states to the south of Michigan.

Slide traps have been sunk to the bottom in water 6 to 15 feet in depth in the hopes that by next spring the hydranths may have attached themselves and can be brought to the laboratory for study. As no field work was carried on in Barton Pond during the past summer, we have no indication of the first appearance of the medusae for this season. Many specimens have been preserved in 5 per cent. formalin, and samples are available to zoologists especially interested.

ARTHUR E. WOODHEAD

UNIVERSITY OF MICHIGAN

RATTLESNAKE POISONING BY SELF-INFLICTED BITES

IN the issue of SCIENCE for July 7, 1933, page 13, H. K. Gloyd, of the University of Michigan, writes of the effect of water moccasin venom upon a rattlesnake. In the course of the article Mr. Gloyd says: "Almost every one who has kept living venomous snakes for study has observed that on occasion they fortuitously bite themselves or others of their own or closely related species without the occurrence of noticeable reactions."

In this connection it may be of interest to report a case which occurred in our zoological laboratory two years ago. On June 16, 1931, I captured an eight-rattled rattlesnake, *Crotalus confluentus confluentus* (Say), on the prairie and kept it in captivity through the summer. On August 24, or possibly a day or so earlier, this snake gave birth to ten young.

On August 31 two observers were disturbing the snakes by shaking the cage. Soon the snakes were striking promiscuously, the old one as well as the young. During this mêlée one little snake was seen to strike itself in about the middle of its length and to have difficulty for a moment in releasing the fangs from itself. It soon began to show signs of serious effects of the poison, and I was called in to observe it. The snake was writhing and twisting in apparent agony. Within five minutes after my observation began, it had ceased its contortions and appeared nearly lifeless. It was swollen for an inch or so in the region of the bite.

The incident occurred at about 10 A. M. When I returned to the laboratory in the afternoon, the snake was entirely lifeless.

L. D. WOOSTER

FORT HAYS KANSAS STATE COLLEGE
HAYS, KANSAS

PRELIMINARY NOTE ON THE OCCURRENCE OF VITAMIN A IN THE OIL OF WEST INDIAN SHARKS

SAMPLES of the oil from the livers of two West Indian sharks, *Carcharhinus* sp., caught in the waters along the northern shore of Puerto Rico, were assayed by the bio-method of Sherman.[1]

Four levels of the oil (7.5 mg, 5.0 mg, 2.5 mg and 1 mg per day) were fed to four different groups of white rats, laboratory stock, containing respectively 6, 8, 7 and 11 rats. Two or more negative controls were run with each group.

All levels gave excellent results and even the lowest level, 1 mg, per day, gave an average growth of more than 24 grams in a period of eight weeks after depletion, and the early symptoms of xerophthalmia disappeared in a few days. All negative controls died in about four weeks after depletion.

The casein for the depletion diet was purified by the method recommended by M. T. Potter,[2] which method proved to be very reliable and economical.

C. F. ASENJO

RENSSELAER POLYTECHNIC INSTITUTE

[1] Contribution from the Zoological Laboratory of the University of Michigan.

[1] H. C. Sherman and S. L. Smith, "The Vitamines," Chemical Catalog Company, 1931.
[2] M. T. Potter, SCIENCE, August, 1932.

SPECIAL CORRESPONDENCE

THE TWENTY-NINTH ANNUAL NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

THE annual field days of the New England geologists for 1933 were on the 13th and 14th of October, and the excursions were made in the vicinity of Williamstown, Massachusetts, under the leadership of Louis M. Prindle and Eleanora F. Knopf, of the U. S. Geological Survey, and Herdman F. Cleland and Elwyn L. Perry, of Williams College. The group assembled at Mohawk Park, two miles west of Charlemont on the Mohawk Trail, at 2:00 P. M. Friday afternoon and proceeded westward toward Williamstown.

The main purpose of the study was to comprehend the difficult structures involved in the Green Mountains and the Taconic Range, as interpreted by Mr. Prindle and Mrs. Knopf in a recent paper on the "Geology of the Taconic Quadrangle."[1] The varved clays and terraces of Glacial Lake Bascom lying in the valleys, west of the Hoosac Range, were also studied, as well as the erosion surfaces truncating the summits of the many surrounding hills.

The valley of Cold River was followed toward Hoosac Mountain and the first outcrops encountered were ledges of the Savoy schist, a sericite-chlorite schist, overlying the Rowe and Hoosac schists. All these schists were placed in the Ordovician period by B. K. Emerson,[2] but the more recent interpretation suggests that they are Cambrian in age.

The weather was particularly favorable during both days of the excursion and distant views of the mountains of New England were exceptionally clear. The first of these views was obtained from the Lower Tower on the eastern slope of Hoosac Mountain. Monadnock Mountain in New Hampshire and Wachusett Mountain in Massachusetts were both visible and at least two Tertiary erosion surfaces could be distinguished. The rock outcropping near the tower was the Rowe schist, a pale-green, chlorite schist which overlies the Hoosac schist and is distinguished from it by a finer grain and the absence of albite metacrysts. Since the beds dip eastward, the older Hoosac schist is exposed on the western summit of the Hoosac Range. At the Upper Tower on this western summit there is a considerable amount of quartz in the Hoosac schist, and the question concerning its origin was not satisfactorily answered. Some believed it was segregated from the surrounding schist, and others believed that it was intruded by later granitic magmas.

[1] *American Journal of Science*, v. 24, pp. 257–302, 1932.

[2] "Geology of Massachusetts and Rhode Island," Bull. 597, U. S. Geological Survey, pp. 40–42, 1916.

Approaching North Adams from the east the party turned northward to Hudson brook and visited an agricultural lime quarry in the Rutland dolomite. Here there was a natural bridge and an overturned fold exposed in the north wall of the quarry. Excessive crumpling of the thin beds forming the limbs of the fold caused them to thicken and to thin within the outcrop in a most astonishing manner.

At this point the party divided and one group visited the unconformity between the Cheshire quartzite and the Stamford granite gneiss of Precambrian age, north of the natural bridge locality. The other group drove to a brick yard on the road toward Williamstown, just west of North Adams, and studied the varved clays of Glacial Lake Bascom.

Friday evening an assembly was held at the Geological Museum of Williams College. Professor Cleland gave a brief résumé of the various stages in the geologic mapping of the Taconic area, beginning with Amos Eaton, a professor at Williams at the beginning of the nineteenth century. The guides each explained their particular localities, which were on the program for the excursion, and a large model of the vicinity of Williamstown was exhibited by Dr. Perry, which showed clearly the recent mapping by Mr. Prindle and Mrs. Knopf. It emphasized the point made by these geologists that the Rowe schist which forms most of the Taconic Range in this area had no homeland here, but was thrust into this region from some district far to the east. The normal Green Mountain series, or Eastern sequence, consists of the Precambrian schists and gneiss forming the core of the range overlain to the west by the basal Cheshire quartzite of Lower Cambrian age, the Rutland dolomite of Cambrian age and the Stockbridge limestone and Walloomsac slate of Ordovician date. A major thrust plane separates these rocks throughout the Taconic area from the entirely different series of Cambrian rocks (the Rowe schist) overlying them.

To the west and north the normal sequence of rocks overlying the Precambrian Adirondack area is well known. It includes the basal Potsdam sandstone of Upper Cambrian age, the Ordovician limestones and shales of the Canadian and Mohawkian series, including such well-known formations as the Chazy, Trenton and Utica. Within these formations there is no possibility of inserting the thick Rowe formation. Hence the evidence is quite clear that the bulk of the sediments forming Greylock Mountain and the many ridges of the Taconic system have been thrust into their present position from some area to the east and have undergone progressive and retrogressive metamorphism in the process, as well as later hydrothermal alteration.

Saturday morning thirty-six cars, containing over one hundred geologists, drove northward to Pownal, Vermont. There they turned northwestward on Route 112 along the north side of the Hoosac River. Somewhat over six miles from Williamstown they found outcrops of the albitic Rowe schist similar to that seen on the west summit of Hoosac Mountain. Less than a mile beyond there was a limestone quarry in which the structure of the region was sensationally epitomized. The Ordovician limestone (Stockbridge) and the Walloomsac slate were tangled in folds overturned to the west and thrust up through a window in the Rowe schist of the traveled cover which usually lies above them within the Taconic area. But here the normal Eastern Sequence is thrust over the green schist which had previously been thrust over them. Was it any wonder that the uninitiated were unable to follow the complexities of that tangle?

Continuing, the party crossed the border into New York State and turned southward at Hoosick towards Petersburg. This is the region of the Lower Cambrian purple and green slates of Vermont and New York. They include the Bomozeen grit and the Mettawee slate of the New York State Survey, within which Lower Cambrian fossils have been found. Mr. Prindle includes these in his Taconic sequence with the Rowe schist and believes they were the advance guard of the overthrust blocks from the east, which were not so highly metamorphosed as the Rowe and Hoosac schists.

Ascending the beautifully graded road leading eastward from Petersburg (Route 16) an extended stop was made at the summit of Petersburg Gap. The gorgeous autumn colors stood out in their glory as the eye traveled westward toward the Rensselaer Plateau. This view offered a pretext for the discussion of the age of the Rennselaer grit. Dr. Rudolf Ruedemann suggested that it was the continuation of the Upper Devonian rocks of the Catskills across to the eastern side of the Hudson River. Mr. Prindle was inclined to place them in the Cambrian period as a part of his Taconic sequence, since they were tucked in under the Rowe schist apparently above the plane of the Taconic overthrusts, east of Moon Hill, Petersburg, New York. With this opinion Mrs. Knopf was inclined to agree, although she admitted the evidence was not conclusive.

The party then descended to the east to Taconic Park at the foot of the Taconic Trail. Here members of the Williams faculty, ably directed by Mr. and Mrs. Cleland and Mr. and Mrs. Perry, served a delightful steak roast. Strengthened by this meat the automobilists took courage and drove to the top of Mount Greylock (3,508 feet). The clear atmosphere continued into the afternoon and most of New England and New York lay at our feet—Monadnock, Wachusetts and the trap ridges of the Connecticut Valley to the east, the White and the Green Mountains to the northeast and north, the Adirondacks to the northwest and the Catskills to the west and southwest.

Ending with such a climax, the twenty-ninth excursion must be considered one of the most successful of the New England geologic excursions. Guests were present from many parts of New York State and Pennsylvania, and practically all the New England colleges were represented, as well as several high schools and normal schools.

DR. W. G. FOYE,
Secretary

SCIENTIFIC BOOKS

INFECTION OF INSECTS

L'infection chez les insectes. By A. PAILLOT. Imprimerie de Trevoux, G. Patissier, 1933, 535 pp., 279 figures.

LEADING investigators are often too busy advancing our knowledge to describe their chosen field systematically in book form. But there are exceptions, and Paillot is one. In his introduction he mentions the ambition of Pasteur to employ microorganisms in the destruction of harmful insects. The reason why this has not been realized is, in his opinion, that investigators have been inadequately prepared through lack of knowledge of the insects themselves. Success can only be expected when the infections of insects are studied intensively in a broad way, not merely in respect to their immediate influence on man by the production of disease or by economic losses. In other words, host-parasitic relations among the insects must be emphasized, for it is in this way alone that a true conception of the problem involved can be secured. The presentation is divided into seven parts: Protozoan, mycotic, virus and bacterial infections, bacterial immunity, symbiosis and economic considerations. Since the insects are small and the infective agents of microscopic or ultramicroscopic dimensions, methods of cytologic study are stressed. Often the only evidence of infection is the presence of intracellular bodies so tiny that the determination of their organismal nature is no mean task. In other cases the presence of infection must be gauged by some peculiar deviation in the normal behavior of the afflicted cells. Paillot, by his close association with the Lyon school of cytologists, headed by Policard, is especially well able to handle this situation. His description of the virus diseases of insects is particularly good. It

serves to extend our horizon in the biologic significance of viruses at a time when this is sorely needed. His account of symbiotic organisms is also timely. If their presence had always been recognized, some workers might have been spared waste of time and disillusionment in the search for organisms pathogenic for man and domestic animals. There is a very useful bibliography, a brief analysis of subjects and author and subject indices. The illustrations are excellent. The infections of insects are treated more thoroughly and more critically than has ever been done before. The volume should be of great service to biologists, pathologists, entomologists, public health officials and to all those who realize the economical and medical importance of insects in human welfare.

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FORAMINIFERA

Foraminifera, Their Classification and Economic Use, second edition, and *An Illustrated Key to the Genera of Foraminifera.* By JOSEPH A. CUSHMAN, Cushman Laboratory for Foraminiferal Research, Special Publication Nos. 4 and 5. Sharon, Massachusetts, 1933.

JOSEPH A. CUSHMAN, in 1928, issued, under the title "Foraminifera, Their Classification and Economic Use," the most comprehensive review of the Foraminifera published up to that time. In August of 1933 appeared a second edition of this work, revised and greatly enlarged, and accompanied by "An Illustrated Key to the Genera of the Foraminifera." In this new edition, many additional plates show the evolution of the genera and families, and several introductory plates illustrate the more common structures for the especial use of students beginning work on these forms. Also, many generic diagnoses new to the first edition have been added. The chapters on the two specialized fields of Fusulinidae and Orbitoidae were written by Professor Carl O. Dunbar, Yale University, and Professor T. Wayland Vaughan, respectively, specialists in these two fields.

The author has visited many of the foreign museums and examined their types, with the result that the types or topotypes of at least 95 per cent. of the known genera have come directly under his observation; so that the work is based upon actual material rather than upon the often inadequate original descriptions and figures. It is also apparent that this classification of the Foraminifera is based not alone upon the personal ideas formed during the author's thirty years of intensive study, but cognizance is taken of the best thought developed by the many workers since Brady's classification in 1884.

The extensive bibliography arranged by subjects which brings the volume to a conclusion will be an immense help to all students of these forms, as will also the ten introductory chapters upon the living animal, methods of study, distribution and other general topics.

In appearance these volumes leave nothing to be desired. Of a size convenient for handling, the excellent paper, type and unusually fine illustrations reflect great credit upon the Cushman Laboratory. The plates in the "Key" are particularly attractive and set forth a new feature, namely, the carrying out of the figures nearly to the edge of the plates, thereby permitting the placing of more figures on each plate and thus rendering possible direct reference from plate to description. The black background also brings out the details of the Foraminifera in a way that no other method would accomplish. Lastly, the fact that the plates can be used without constant turning, while one studies the various genera in the larger book, is a convenience that will appeal to every student. Students of the Foraminifera are to be congratulated that such a useful volume is available for their use.

R. S. BASSLER

SCIENTIFIC APPARATUS AND LABORATORY METHODS

RECOVERY OF CARBON TETRACHLORIDE[1]

IN the course of certain investigations in the laboratory of gastro-enterology at the Evans Memorial, extraction of fatty acids from previously treated bile is a part of a routine procedure.

Recovery of the carbon tetrachloride became desirable from the economic standpoint. In the course of the recovery the volatilization of the carbon tetrachloride resulted in distress among the laboratory workers. They developed nausea and dizziness. With the possibility that continued exposure to the fumes might result in chronic poisoning, the recovery of the carbon tetrachloride was studied whereby the fumes would not escape into the room and also be almost if not completely recovered.

The following method has been adopted and the apparatus for same is illustrated in Fig. 1. The carbon tetrachloride extract is placed in the Erlenmeyer flask (A). The flask is warmed by means of an electric heater. As the carbon tetrachloride is

[1] From the Department of Pharmacology, Boston University School of Medicine, the Evans Memorial and the Massachusetts Memorial Hospitals, Boston.

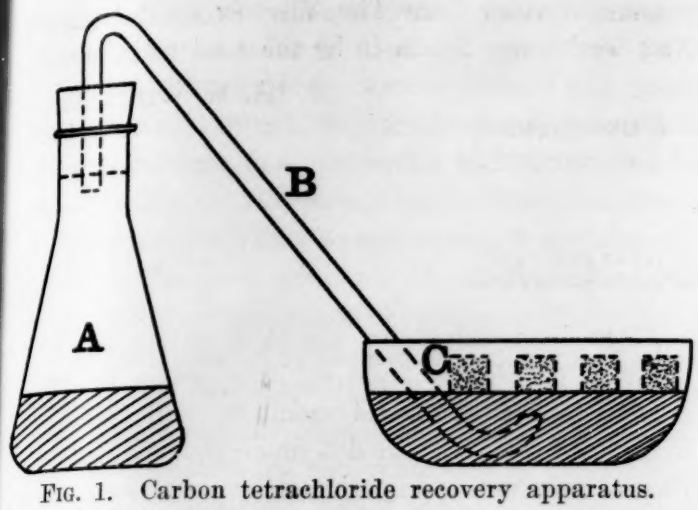

FIG. 1. Carbon tetrachloride recovery apparatus.

volatilized, it escapes through the tube. The distal end of tube (B) dips into and down to the bottom of a kidney-shaped enamel pan, which is filled to the depth of 1 or 2 inches with metallic mercury. On the surface of the mercury ice cubes (C) are placed in order to keep the mercury cool. The kidney-shaped pans are used so that they may encircle the electric heater when several extracts are volatilizing at the same time. Any suitable container for the mercury may be used.

When the electric heater is started, the volatilized carbon tetrachloride escapes through the distal end of tube (B) under the mercury. In its passage to the surface of the mercury it condenses and emerges as liquid carbon tetrachloride. The liquid carbon tetrachloride then can be readily poured off from the mercury and easily separated by use of a separatory funnel from the water which has resulted from the melting ice.

The advantages of this method are important from both the economic and health angle. Practically all the carbon tetrachloride can be recovered and the method is extremely simple. It does away with all escape of fumes into the room. Nine flasks have been used at one time, with no odor of carbon tetrachloride in the room. The distress complained of by laboratory assistants disappeared. Various other methods of recovery were tried, including removal by suction. None of them was capable of completely excluding the fumes. The method here reported has been used very successfully, is efficient and inexpensive.

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A SIMPLE AGITATION DEVICE[1]

A SIMPLE device for the moderate agitation of solutions is shown in the accompanying diagrams. All one side, except a strip B about one inch wide and running lengthwise, is cut out of a gallon oil-can A.

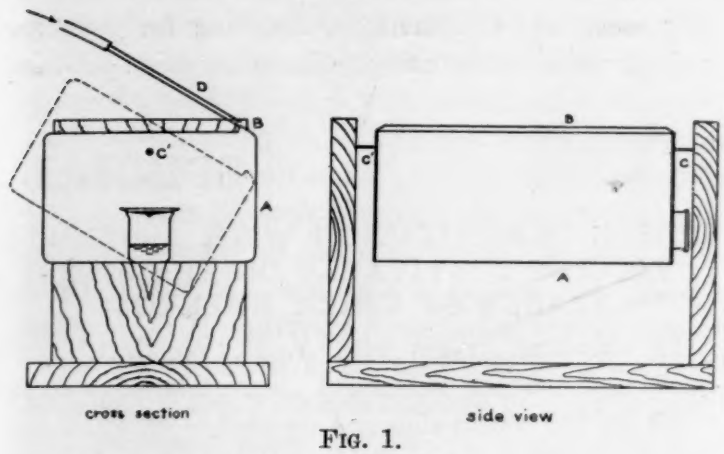

FIG. 1.

This strip is bent slightly upwards as indicated. The can is then mounted by means of nails between two upright boards. The holes in the can must be of such diameter that oscillation can occur freely. C and C′ indicate the positions of support.

When a stream of compressed air is passed through the glass tube D, striking the edge B, the can rocks back and forth on the nail supports. The amplitude may be controlled by regulating the air supply and the distance of the end of the glass tube from the edge of the can.

Vessels containing solutions to be shaken may be held in position by wires which are properly spaced and run lengthwise through the can. If beakers are used, watch glasses may be fastened on with rubber bands.

GRAHAM W. MARKS

A METHOD OF INCREASING THE YIELD OF DROSOPHILA

DURING the course of experimentation with different types of food media for raising *Drosophila melanogaster* at the University of Texas, the author discovered that the yield could be greatly increased by the addition of dried brewers' yeast to the culture media. Accurate counts were made under controlled conditions, and the yield was found to be about ten times greater after the addition of the yeast than in plain banana food and almost twice as great as in banana food with autoclaved fresh bakers' yeast added. When added to corn-meal food the brewers' yeast increased the yield in the ratio of 5:2. Since the yeast is very reasonable in price and convenient to handle, it should prove a source of great saving in the study of Drosophila.

The amount of yeast to be added depends on the richness of the food desired, but for general use about two grams per 100 cc of media will be satisfactory. It may be added as soon as the agar has dissolved and

[1] Contribution from the Scripps Institution of Oceanography of the University of California, La Jolla, California.

boiled with the food. Although the yeast is dehydrated, it may contain some spores which might cause a slight fermentation. This difficulty, however, may easily be overcome by autoclaving the yeast for a short while before using. The plain dried brewers' yeast (procured from The Vitamin Food Company, New York) was found to be the most satisfactory.

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SPECIAL ARTICLES

HUMAN IMMUNIZATION WITH A DERMAL VACCINE CULTIVATED ON THE MEMBRANES OF CHICK EMBRYOS[1]

IN previous papers with A. M. Woodruff[2,3] we have reported the successful cultivation of vaccine virus on the chorio-allantoic membrane of chick embryos, following the method of Woodruff and Goodpasture in their study of fowl-pox[4]; and we have suggested that this method be applied to the preparation of anti-smallpox vaccine on a large scale. Recently these experiments have been successfully repeated with dermal strains of vaccine by Nauck and Paschen[5] and by Stevenson and Butler.[6]

With the purpose of determining the practicability of preparing and using vaccine cultivated on the chick membranes for human vaccination, we began 15 months ago culturing a dermal strain of vaccine derived from the laboratories of the New York City Board of Health. It was found that an infection free of bacteria could frequently be obtained on primary inoculation, but to insure bacterial sterility the infected membranes were ground and filtered through a Berkefeld N candle. The filtrate, having shown no growth on bacterial media, was centrifuged and a pure strain of vaccine was obtained by inoculating the sediment upon the exposed chorio-allantoic membranes of 10 and 12 day chick embryos. This strain has been propagated during the past fifteen months through eighty-five successive generations without mammalian passage, and apparently it has become stabilized.

The results of the work of the past year have convinced us of the practicability of preparing by this method a vaccine, free of bacteria, with a potency and durability that will insure a stable product over a sufficiently long period to be safe and reliable under field conditions. The vaccine may be preserved dry or glycerinated, and except for its cultivation it is prepared and utilized in the manner now employed for calf vaccine.

After determining that the chick vaccine shows no essential differences from calf vaccine in its pathogenicity for rabbits and monkeys, and that it induces, so far as we can determine by serological and crossed vaccination experiments, an equally substantial immunity in these animals, we made observations upon its effects in man.

Seventeen persons, ranging in age from 3 to 40 years, were chosen. They were judged to be non-immune from the fact that vaccination scars were absent. They were vaccinated over the deltoid muscle of the left arm by the scratch method in the following groups.

Seven persons were inoculated with a dermal strain of vaccine virus which had been carried on the chick membrane through six successive passages. This virus had been stored in the refrigerator at 0° C. over a period of five months, and was finally prepared by adding four parts of 50 per cent. glycerol to one part of ground material. Bacteriological tests proved this vaccine to be entirely free from contaminating micro-organisms. Tests on the rabbit proved it to be of reliable potency.

Seven persons were inoculated with a regular calf strain of vaccine virus prepared by E. Squibb and Sons. This was contained in capillary pipettes in the usual manner of vaccine virus prepared for routine vaccinations. These vaccinations were performed to serve as a control and for comparison with the reactions produced by the chick strain of vaccine.

Four persons were vaccinated with a dermal strain of vaccine virus which had been cultivated on the chick membrane through seventy-five successive passages. This vaccine had been stored in the refrigerator for a period of three months and was prepared in the same manner as mentioned above.

Of the seven persons vaccinated with the regular calf strain of virus, one failed to develop any reaction. One developed a typical vaccinoid reaction which reached its height on the sixth day and then rapidly subsided. The remaining five developed a typical vaccinia which reached the height of its reaction on the tenth to the twelfth day. These reactions were typical in every respect as to the appearance of the successive stages of the lesions and the

[1] Aided by grants from the Divisions of International Health and Medical Sciences of the Rockefeller Foundation.

[2] SCIENCE, 74: 1919, 371, 1931.

[3] *Amer. Jour. Path.*, 8: 271, 1932.

[4] *Amer. Jour. Path.*, 7: 209, 1931.

[5] *Zentrbl. f. Bakt., Parasitkd., u. Infkr.*, I Abt. Orig. 128, 171, 1933.

[6] *Lancet*, ccxxv, 228, 1933.

general symptoms of malaise, slight fever and adenitis.

Of the seven persons vaccinated with the vaccine virus carried through six successive passages on the chick membrane one responded with a typical vaccinoid reaction. The remaining six developed typical vaccinia lesions which passed through the successive stages in the usual manner. General symptoms also were typical of the disease.

The four persons vaccinated with the vaccine virus carried through seventy-five successive passages on the chick membrane all responded with positive takes and developed lesions and symptoms in every respect typical of vaccinia.

Daily observation and comparison of the lesions produced by the regular commercial vaccine and those produced by the vaccine cultivated on the chick membrane showed them to be quite comparable to each other throughout their entire course. The following differences were noted. The lesions developing from the virus cultivated on the chick embryo were slightly milder in their appearance. The different stages of the lesion were delayed about one day, as compared with those appearing from the regular calf vaccine. There was less induration of the surrounding subcutaneous tissues, and the involvement of the adjacent lymph nodes was not quite so extensive. In the pustular stage the lesions from the chick strain of vaccine did not contain as large an amount of pus. The crusts were thinner and more flaky and when separated did not leave so marked a depression as those from the calf strain of virus. On the whole the lesions from the chick strain of vaccine were less painful and caused less discomfort.

The lesions produced by the vaccine virus carried through seventy-five passages on the chick membrane were definitely milder throughout the first eight days of their course, but passed through the successive stages in a typical manner. They then rapidly increased in severity to reach their height on the tenth to the twelfth day when their appearance was quite comparable to the lesions produced by the regular calf strain of virus.

The scars left by all the vaccinations are quite comparable as to size, all averaging about 1 to 1.5 cm in diameter. They are all slightly depressed below the surrounding surface. Those produced by the calf strain of virus are slightly deeper. There is evidently less scar tissue formation in the lesions produced by the chick strain of vaccine, as they feel thinner and are less pitted and wrinkled.

The persons vaccinated with the calf strain of virus and the virus from the sixth passage on the chick were revaccinated nine weeks after the primary vaccinations by the scratch method. A control scarification was made in each case. Those vaccinated with the virus from the seventy-fifth passage were revaccinated in the same manner eight weeks after the primary vaccinations.

The persons vaccinated with the chick strain of virus were revaccinated with a calf strain of vaccine virus prepared by E. Squibb and Sons. Those vaccinated with the calf strain of virus were revaccinated with a strain of chick vaccine from the sixth passage of good potency as tested out on the rabbit.

Except in the case of one person who failed to respond to the primary vaccination typical immune reactions developed in all cases following the revaccination. These were characterized by a slight papule and reddening along the line of scarification which were present after twenty-four hours and reached their maximum intensity between twenty-four and forty-eight hours. By the end of seventy-two hours all reactions had subsided. Several had completely disappeared, while a few were still present as a small papule with very slight reddening along the scarification. Observations on the seventh day showed the lesions had subsided.

Some of the advantages which might be expected from the use of chick embryo vaccine over the calf virus are the ease with which it may be produced at any time fertile hen-eggs are available, absence of bacteria and other contaminating agents, and, if present indications are confirmed, the availability of a fixed strain of virus which does not require mammalian passage to maintain its virulence.

Additional studies are in progress intended further to simplify and improve the technique of chick vaccine production and to test the relative durability of its immunizing effect in man.

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THE EFFECT OF IRON ON THE ESTABLISHMENT OF THE OXIDATION-REDUCTION POTENTIAL OF ALLOXANTIN

ON considering the various instances where heavy metal salts act as catalysts in oxidation-reduction processes, the following observation seems to be of interest in which iron acts as a catalyst for the establishment of an oxidation-reduction potential.

Biilmann and Lund[1] have shown that an acidified solution of alloxantin establishes a definite potential at the blank platinum or gold electrode. The interpretation is based on the well-founded assumption that alloxantin in an aqueous solution is split into dialuric acid and alloxan and that these two substances behave as the components of a reversible oxidation-

[1] E. Biilmann and H. Lund, *Ann. Chim.* (9) 19: 137, 1923.

reduction system. The case of alloxantin is thus analogous to that of quinhydrone. Richardson and Cannan[2] extended the potentiometric study over a wide pH range and performed oxidative potentiometric titration experiments which, in spite of difficulties with respect to the lack of stability of the potentials, led to reasonable results.

The reproduction of Biilmann's experiment is easy, provided one works with rather concentrated solutions of alloxantin (about 0.3 per cent.), best in saturated solution with an excess of solid alloxantin. In this case, of course, oxidative or reductive potentiometric titration experiments can not be performed.

On the occasion of our own potentiometric study of alloxantin it appeared to us striking that the potentials become erratic, inconstant in time and irreproducible, when a somewhat diluted solution of alloxantin is used instead of a saturated one, a fact which has never been mentioned anywhere. A further study showed that on the addition of a small amount of an iron salt the potentials become reproducible and are rapidly established, even in very dilute solutions of alloxantin (1: 10,000 and even more dilute). Mere traces of iron are not sufficient to establish the full effect, but well-measurable amounts are requisite. About 0.1 to 1.0 milligram of iron, as sulphate, added to a volume of 25 cc of the solution is necessary. On the other hand, in a concentrated solution of alloxantin, Fe is not requisite. On working with all precautions as Fe-free as possible and adding such powerful Fe-combining reagents as alpha, alpha'-dipyridyl, or alpha, alpha'-phenantrolin the potentials are quickly established in concentrated solutions.

Alloxantin can be reduced in the electrode vessel by hydrogen and colloidal palladium to dialuric acid, and after replacing the hydrogen by nitrogen an oxidative titration experiment with bromine can be performed. The oxidation product is alloxan. The establishment of the potentials is sluggish and erratic. When, however, a small amount of $FeSO_4$ had been added to the mixture, the potentials are immediately established, just as with any reversible dyestuff. The shape of the titration curve is precisely the one of an ordinary organic dyestuff system, with no indication of any intermediary step of oxidation being shown. This intermediary form, known as alloxantin in the crystalline state, does not exist to any appreciable extent in the solution, just as the substance called quinhydrone in its crystalline state does not exist in solution. The titration curve is not influenced at all by the adding even of a great excess of iron.

The effect of the iron is most evident between pH 4 and 6. At lower pH the effect is small and at pH about 1.0, where Biilmann and Lund worked, no appreciable effect of iron can be seen any more. At so low a pH only a concentrated solution of alloxantin establishes a reproducible potential, and this is not influenced at all by iron.

Iron can not be replaced by copper, manganese, cobalt, nickel or organic dyestuffs.

As for the explanation of this effect, it should be recalled that dialuric acid gives a complex compound with iron. This can be shown, however, only in an alkaline solution. Dialuric acid plus $FeCl_3$, plus ammonia, produces a deep violet color. At the pH range 4 to 6, where the effect of iron on the potential is strongest, no evidence of any complex formation can be shown. No color and no precipitate is produced by the iron. If there exists, at pH 4–6, a Fe complex at all, this complex can represent only a very slight fraction of that part of the substance not combined with Fe. Yet, this minute trace of the complex may be considered as the intermediator for the establishment of the potential. Without emphasizing too much this hypothesis, at any rate, this is another case of the catalytic establishment of a potential in a system which is thermodynamically reversible but sluggishly reactive without a catalyst.

It should be recalled[3] also that Fe acts as a catalyst for the oxidation of dialuric acid by molecular oxygen. The pH optimum of this effect is around pH 7, whereas the effect described above has its optimum at pH 4–6.

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[3] Edgar S. Hill, *Jour. Biol. Chem.*, 92: 471, 1931.

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